Fact Sheet

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Power Uprates for Nuclear Plants

Background

Utilities have been using power uprates since the 1970s as a way to increase the power output of their nuclear plants. To date, the NRC has completed 62 such reviews. (See Table 1) Collectively, an equivalent of approximately two large nuclear power plant units (each approximately 3760 megawatts thermal (MWt)) has been gained through implementation of power uprates at existing plants. NRC licensees have indicated they plan to ask for power uprates over the next five years, that if approved, would add another 4870 MWt to the nation's generating capacity.

Discussion

To increase the power output of a reactor, typically a more highly enriched uranium fuel is added. This enables the reactor to produce more thermal energy which is used to produce more steam to drive a turbine generator, which produces electricity. In order to accomplish this, components such as pipes, valves, pumps, heat exchangers, electrical transformers and generators, must be able to accommodate the conditions that would exist at the higher power level. For example, a higher power level usually involves higher steam and water flow through the systems used in converting the thermal power into electric power. These systems must be capable of accommodating the higher flows.

In some instances, licensees will modify and/or replace components in order to accommodate a higher power level. Depending on the desired increase in power level and original equipment design, this can involve major and costly modifications to the plant such as the replacement of main turbines. All of these factors must be analyzed by the licensee as part of a request for a power uprate, which is accomplished generally by amending the plant's operating license. The analyses must demonstrate that the proposed new configuration remains safe and that measures continue to be in place to protect the health and safety of the public. These analyses are reviewed by the NRC before a request for a power uprate is approved.

Power uprates can be classified in three categories: (1) measurement uncertainty recapture power uprates, (2) stretch power uprates, and (3) extended power uprates.

1) Measurement uncertainty recapture power uprates are about 1.5 percent power increases and are achieved by using enhanced techniques for calculating reactor power. This involves the use of state-of-the-art devices to more precisely measure feedwater flow which is used to calculate reactor power. More precise measurements reduce the degree of uncertainty in the power level which is used by analysts to predict the ability of the reactor to be safely shut down under some accident conditions.

2) Stretch power uprates are typically on the order of up to seven percent and usually involve changes to instrumentation settings. Stretch power uprates generally do not involve major plant modifications. This is especially true for boiling-water reactor plants. In some limited cases where plant equipment was operated near capacity prior to the power uprate, more substantial changes may be required.

3) Extended power uprates are usually greater than stretch power uprates and are expected to be submitted for increases as high as 20 percent. Extended power uprates usually require significant modifications to major pieces of plant equipment such as the high pressure turbines, condensate pumps and motors, main generators, and/or transformers.

Review Process

Power uprates are submitted to NRC as license amendment requests. The applications and reviews are complex and involve many areas of NRC including various technical divisions of the Office of Nuclear Reactor Regulation and the Office of the General Counsel. Some reviews may also involve the Office of Nuclear Regulatory Research and the Advisory Committee on Reactor Safeguards. In evaluating a power uprate request, NRC reviews data and accident analyses submitted by a licensee to confirm that the plant can operate safely at the higher power level. Reviews of power uprate requests are a high priority and are therefore, being conducted on accelerated schedules.

To date, reviews of "measurement uncertainty recapture power uprate" applications have taken about six to eight months to complete. The staff recently issued draft guidance to the industry for developing standardized submittals for high quality power uprate applications. This guidance covers analyses of the effect of the power uprate on things such as electrical equipment, major plant systems, and emergency operating procedures. Use of the guidelines may allow NRC to reduce the review time to two to three months.

Reviews of extended power uprate applications, initially estimated to take up to 18 months, are now scheduled for 12 months. This includes approximately two months for coordination and review with the NRC's Advisory Committee for Reactor Safety -- an independent panel of technical experts from diverse fields that advises the Commission.
Based on results of its industry survey, NRC expects to receive only one stretch power uprate each year over the next five years. Therefore, NRC's efforts for improving the power uprate application and review processes will initially focus on measurement uncertainty and extended power uprates. Efficiencies gained there will be applied to improve the stretch power uprate review process.

To keep the public informed of its activities, NRC publishes a notice in the *Federal Register* when it (1) receives a license amendment request for a power uprate; (2) after a finding of no significant impact is made; and (3) if a power uprate is approved. Press releases are also issued if a power uprate is approved.

Current Status

<u>Plant-Specific Applications Under Review</u>

The NRC has 14 applications for power uprates under review. Of these, four are for measurement uncertainty recapture power uprates, while eight are for extended power uprates greater than or equal to 15 percent. The remaining two include one for 4.5 percent and one for 7.5 percent.

The highest power uprate requested to date is 20 percent. A complete list of applications under review can be found in Table 2.

<u>Generic Methodologies</u>

The NRC currently is reviewing a report submitted on July 11, 2000 by General Electric Nuclear Energy (GENE) related to measurement uncertainty recapture power uprates. This report provides a methodology for using a reduced reactor thermal power uncertainty in licensing analyses. The staff expects to complete its review by the end of the year.

In addition, NRC has under review another report submitted by GENE on March 19, 2001, which proposes a streamlined approach for licensees to use in preparing and submitting extended power uprate applications. Because of the combination of (1) the magnitude of power uprates that this report, would apply to (up to a 20-percent increase in power), (2) the limited experience in reviewing power uprates of this magnitude, and (3) the magnitude of reduction in the amount of information to be provided by licensees as proposed in the report, the NRC met with GENE in June to discuss these items. As a result, a revised report was submitted in July and is currently under review.

Future Actions

Licensees have told NRC they plan to submit 42 power uprate applications in the next five years as follows:

11 - extended power uprates (4-6 per year for the next three years)
3 - stretch power uprates (1 per year for the next three years)
27 - measurement uncertainty recapture power uprates (10-15/year for the next 2 years)
1 - unknown size of the expected uprate

The sizes reported for the stretch and extended power uprates may also include measurement recapture uncertainty. Based on the information provided, planned power uprates are expected to result in an increase of about 4870 MWt, the equivalent of about one and a half large plants. Table 3 in the attachment provides a list of anticipated future applications.

Workshop

The agency plans to hold a public workshop next year following completion of the Duane Arnold, Quad Cities 1 and 2, and Dresden 2 and 3 extended power uprate reviews to share lessons learned from these reviews with stakeholders. The staff will also solicit stakeholder input on the agency's review of these applications and ideas for improving the review process.

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Table 1

Approved Power Uprates

(Type - MU = Measurement Uncertainty Recapture, S = Stretch, E = Extended)

No.	Plant	% Uprate	Mwt	Year Approved	Type
1	Calvert Cliffs 1	5.5	140	1977	S
2	Calvert Cliffs 2	5.5	140	1977	S
3	H. B. Robinson	4.5	100	1979	S
4	Millstone 2	5	140	1979	S
5	Fort Calhoun	5.6	80	1980	S
6	St. Lucie 1	5.5	140	1981	S
7	St. Lucie 2	5.5	140	1985	S
8	Duane Arnold	4.1	65	1985	S
9	Salem 1	2	73	1986	S
10	North Anna 1	4.2	118	1986	S
11	North Anna 2	4.2	118	1986	S
12	Calloway	4.5	154	1988	S
13	TMI-1	1.3	33	1988	S
14	Fermi 2	4	137	1992	S
15	Vogtle 1	4.5	154	1993	S
16	Vogtle 2	4.5	154	1993	S
17	Wolf Creek	4.5	154	1993	S
18	Susquehanna 1	4.5	148	1994	S
19	Susquehanna 2	4.5	148	1994	S
20	Peach Bottom 2	5	165	1994	S
21	Peach Bottom 3	5	165	1994	S
22	Limerick 2	5	165	1995	S
23	WNP2	4.9	163	1995	S
24	NMP2	4.3	144	1995	S

No.	Plant	% Uprate	Mwt	Year Approved	Type
25	Hatch 1	5	122	1995	S
26	Hatch 2	5	122	1995	S
27	Surry 1	4.3	105	1995	S
28	Surry 2	4.3	105	1995	S
29	Limerick 1	5	165	1996	S
30	Summer	4.5	125	1996	S
31	Turkey Point 3	4.5	100	1996	S
32	Turkey Point 4	4.5	100	1996	S
33	Palo Verde 2	2	76	1996	S
34	Palo Verde 3	2	76	1996	S
35	Brunswick 1	5	122	1997	S
36	Brunswick 2	5	122	1997	S
37	Fitzpatrick	4	100	1997	S
38	Browns Ferry 2	5	164	1997	S
39	Browns Ferry 3	5	164	1997	S
40	Farley 1	5	138	1997	S
41	Farley 2	5	138	1997	S
42	Monticello	6.3	105	1998	E
43	Hatch 1	8	205	1998	E
44	Hatch 2	8	205	1998	E
45	LaSalle 1	5	166	1999	S
46	LaSalle 2	5	166	1999	S
47	Perry	5	178	1999	S
48	Comanche Peak 2	1	34	1999	MU
49	River Bend	5	145	2000	S
50	Diablo Canyon 1	2	73	2000	S
51	Watts Bar	1.4	48	2001	MU
52	Byron 1	5	170	2001	S

No.	Plant	% Uprate	Mwt	Year Approved	Type
53	Byron 2	5	170	2001	S
54	Braidwood 1	5	170	2001	S
55	Braidwood 2	5	170	2001	S
56	Salem 1	1.4	48	2001	MU
57	Salem 2	1.4	48	2001	MU
58	Susquehanna 1	1.4	48	2001	MU
59	Susquehanna 2	1.4	48	2001	MU
60	San Onofre 2	1.42	48	2001	MU
61	San Onofre 3	1.42	48	2001	MU
62	Hope Creek	1.4	46	2001	MU

Table 2

Power Uprate Submittals Currently Under Staff Review

(Type - MU = Measurement Uncertainty Recapture, S = Stretch, E = Extended)

No	Plant	% Uprate	Mwt	Submittal Date	Projected Completion Date	Type
1	Shearon Harris	4.5	138	12/14/00	9/1/01	S
2	Duane Arnold	15.0	248	11/20/00	10/30/01	E
3	Beaver Valley 1	1.4	37	1/18/01	10/30/01	MU
4	Beaver Valley 2	1.4	37	1/18/01	10/30/01	MU
5	Dresden 2	17	430	12/29/00	11/30/01	E
6	Dresden 3	17	430	12/29/00	11/30/01	E
7	Quad Cities 1	17.8	446	12/29/00	11/30/01	E
8	Quad Cities 2	17.8	446	12/29/00	11/30/01	E
9	ANO2	7.5	211	12/19/00	12/19/01	S
10	Comanche Peak 1	1.4	47	4/5/01	12/31/01	MU
11	Comanche Peak 2	0.4	13	4/5/01	12/31/01	MU
12	Clinton	20	580	6/20/01	TBD	E
13	Brunswick 1	15	371	8/9/2001	TBD	E
14	Brunswick 2	15	371	8/9/2001	TBD	E

Table 3

Expected Future Submittals for Power Uprates

(Type - MU = Measurement Uncertainty Recapture, S = Stretch, E = Extended)

No	Plant	% Uprate	Approximate Submittal Date	Type
1	South Texas 1	1.4	July 2001	MU
2	South Texas 2	1.4	July 2001	MU
3	Palisades	1.4	Fall 2001	MU
4	Crystal River 3	1	Fall 2001	MU
5	Waterford 3	1.7	September 2001	MU
6	Palo Verde 2	2.9	October 2001	S
7	Sequoyah 1	1.3	October 2001	MU
8	Sequoyah 2	1.3	October 2001	MU
9	Grand Gulf	1.7	January 2002	MU
10	Kewaunee	6	February 2002	S
11	River Bend	1.7	April 2002	MU
12	Browns Ferry 2	14	Spring 2002	E
13	Browns Ferry 3	14	Spring 2002	E
14	Point Beach 1	10.1	May 2002	E
15	Point Beach 2	10.1	May 2002	E
16	Beaver Valley 1	5-10	June 2002	E
17	Beaver Valley 2	5-10	November 2002	E
18	Fort Calhoun	15-20	Late 2003	E
19	Grand Gulf	10-12	2004	E
20	Waterford 3	8-10	2004	E

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